The Province of Alberta

PETROLEUM AND NATURAL GAS CONSERVATION BOARD

IN THE MATTER OF THE GAS RESOURCES PRESERVATION ACT

and

IN THE MATTER OF an application by Canadian Delhi Oil, Limited, for a permit authorizing the removal of Natural Gas from the Province of Alberta.

I. N. McKINNON, ESQ. (*Chairman*)
D. P. GOODALL, ESQ.
DR. G. W. GOVIER

DATE 7th May 1951.

VOLUME I

THE COURT HOUSE,
EDMONTON, ALBERTA.

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SITTINGS OF THE BOARD AT
EDMONTON, ALBERTA, AT THE
COURT HOUSE, AT NINE-THIRTY
IN THE MORNING
MAY 7TH, A. D. 1951

MR. McKINNON: Before I ask Mr. Porter to proceed I would like to have the names of those who wish to register as interested parties in connection with this application?

MR. CHAMBERS: I represent the Northwest Natural Gas Company, sir, and Mr. Nolan will probably take on later on in the proceedings.

MR. McDONALD: D. P. McDonald, sir, and I represent the West Coast Transmission, sir.

MR. MARTLAND: I appear on behalf of Western Pipe Lines, sir.

MR. MAHAFFY: I am appearing, sir, for Alberta Interfield Gas Lines Limited.

MR. PARMALEE: I appear for the Northern Natural Gas Company, Omaha, Nebraska.

MR. McLEOD: I am appearing, sir, for McCall Frontenac and Union, sir.

MR. PORTER: If the Board pleases, Mr. Chairman, I am appearing for Canadian Delhi and the successor in interest, Trans Canada Pipelines Limited, and with me is Mr. Ross Tolmie of the Bar of Ontario, and Mr. Glenn Turner of the Bar of Texas.

At the outset, I should say, Mr. Chairman, that unfortunately the material which we will submit to the Board has been late in coming in in a form capable of submission with the result that both the Board and its staff and Counsel have been deprived of an opportunity to examine it in advance as has been the

custom. Now, we would like to say to the Board and to Counsel that while we are anxious to go on, we realize that it may be necessary to adjourn at some stage in order to enable parties and the Board and its staff to review the material which we contemplate submitting. We appoligize for our failure to be ready but the business of compiling this material and printing it took longer than was anticipated and it was late. We are in your hands.

Now, Mr. Chairman, the application for leave to export gas out of Alberta across the prairie provinces and into Ontario and Quebec was made by this Company in September, and in that Application it was stated Parliament was being asked to incorporate a Company under the Federal Companies Pipeline Act, and that has since been accomplished. It was intimated in the Application that when that had been accomplished Trans Canada Pipelines Limited, as it is now known, would be added as a party to these proceedings. I have here copies of the Acts of incorporation, both of the Applicant Company

the Canadian Delhi, which is a Letters Patent Company, organized under the Dominion Companies Act; and Trans Canada Pipelines Limited which was incorporated by Act of Parliament.

MR. McKINNON: Mark those as exhibits, please.

MR. SMITH: There was an Exhibit one, proof of service of the requisite notice.

MR. PORTER: Yes, Exhibit one was proof of service of the requisite notice.

ACT OF INCORPORATION OF CANADIAN DELHI MARKED AS EXHIBIT 2.

ACT OF INCORPORATION OF TRANS CANADA PIPELINES LIMITED MARKED AS EXHIBIT 3.

MR. PORTER: I should say that there are copies of both of these documents available for everyone here and if they would like them now they can have them, they are available.

MR. McKINNON: Would you mind giving some to the Board, Mr. Porter?

MR. PORTER: Yes. Now, Mr. Chairman, I think at this stage I should like to call Mr. Frank Schultz who will describe in outline the contemplated project and to qualify the applicant.

MR. SMITH: As a matter of record, I think, Mr. Steer and Mr. Martland have both come in since you asked Counsel to itentify themselves.

MR. STEER: I am appearing for the Canadian Western and the Northwestern Utilities, sir.

FRANK A. SCHULTZ, 1315 Pacific Avenue, Dallas, Texas, having first been duly sworn, examined by Mr. Porter, justified as follows:

Q Mr. Schultz, I believe you are by profession a geologist?

A Yes sir, I am a geologist, graduate of the University of Oklahoma, 1940.

Q And you are an officer of the Canadian Delhi Oil Limited, the applicant now before the Board?

A I am vice-president of Canadian Delhi.

Q And you did cause through that Company to be

incorporated under Act of Parliament of Canada Trans Canada Pipelines Limited?

A That is corredt.

Q Of which you are an officer?

A I am vice-president of Trans Canada.

Q Now, you are also an officer, I believe, of American Delhi?

A Yes sir, I am vice-president of Delhi, the parent Company.

Q That is the parent Company of Canadian Delhi?

A Yes sir.

Q Now, can you give us something, some indication of the nature of its activities, having in mind that the Board would be interested in knowing what background it has in relation to the exploration for and the transportation of gas?

A Delhi Oil Corporation is a producing oil and gas company. We have several thousand barrels per day oil production and in the last three years our primary exploration programme has been directed towards accumulating and marketing natural gas. In Texas, New Mexico, Colorado, Wyoming, we have substantial reserves; in the Gulf Coast of Texas, and we have developed large reserves in northwestern Mexico, southwestern Colorado, which in the past several months have formed the basis for the realization of a large diameter pipeline from those reserves to California, and that line will go into opperation in the later part of this year and will serve the general SanFransisco area. We entered that

picture at a time when gas was of questionable value, I will say, and we developed reserves and fought through our own Federal Power Commission the project that will be realized this fall.

Q And you have personnel with that Company whose busines it is to deal with, search for and produce and transport gas to market?

A Yes sir, we have adequate personnel and we think we have the best in the business for finding gas and developing it and marketing it.

Q Now, when did you become interested in Alberta, Mr. Schultz?

A Approximately two years ago I made my first trip up here entirely as a reconnaissance proposition. We knew nothing of the Alberta oil or gas situation at that time. It was obvious after that investigation that potentially there was a lot of gas in Alberta. I can honestly say that we had never seen an area where so much gas has been found incidental to looking for oil. Later, last year, I made a second, I made a third trip back and it was at that time that we made up our minds definitely to enter the Alberta picture and to attemot to develop gas reserves for this project that we had under consideration.

Q Now, as a result of that decision have you actually undertaken to drill for and acquire gas properties in Alberta?

A Yes sir. At the time we made up our minds to enter the picture, within a week after we had received our permit to do business in Alberta

we were actually drilling our first well which resulted in the discovery of a new area which we refer to as the Cessford Area. We followed that up immediately with a. well approximately, another wild cat approximately eight miles south which discovered a new area and we moved then eight miles east and discovered still a third area. We were as surprised as anyone else that our first three wells resulted in the discovery of three previously unknown gas producing areas. At that point we accelerated our programme and put several rigs to work looking exclusively for gas. To date we have completed sixteen wells, nine of which have been completed as gas wells and six as dry holes, and one is drilling and we should know the results of that today. Of those nine gas wells we consider that seven of them are wild cat discoveries. We recognize that in addition to discovering new areas that for the gas fields that are already in existence there are producing limits that are to be defined. So, as a supplement to the primary programme of discovering new reserves, we have attempted and been successful in buying some of these one-well gas fields and two of these, three of these wells have been extensions to the one-well gas fields we purchased.

Q Now, Mr. Schultz, do I understand that this programme is still continuing?

A Yes, it is, at the present time we have two wells, we have one well drilling and when the

road ban is lifted we have five locations made which we are ready to move in on immediately, we have the rigs contracted for.

Q You have the rigs contracted for?

A Yes, just waiting for the road situation to clear up.

Q Now, I think all this activity thus far has been pretty well confined to the vicinity of and south of Edmonton; do you contemplate activity in the country west of, let us say, the C. and E. Railway and in the Peace River?

A Yes, that is our next step, in fact our operations have already extended to take in a much wider area and we are looking and trying to find a situation, I will say, in the foot-hills that we can drill right now, and we are attempting to work out some deals to drill some wells in the Peace River country.

Q Do you contemplate any drilling in Saskatchewan?

A Yes sir, that will be a next step in attempting to develop reserves in Saskatchewan to further substantiate the feasibility of this project.

Q Now, this money has not been raised that you are spending on these ventures, it is the Company's own money?

A Yes sir, it is our oil production we are putting into gas wells.

Q Yes?

A Also, in addition to drilling these wild cat ventures that we are attempting in Saskatchewan and Peace River and the foot-hills area, we are going forward

rapidly to develop and define some of these one-well gas fields that we now have that we have purchased and that we acquired by farm-out from some of the major companies; and we actually have three deals with one of the major companies pending right now to drill several wells around two one-well gas fields and of the five wells we have ready to spud in,one of them will be an extension to the Countess Area which will be extended three miles to the north, and Cessford Number Five is to be in between two of the wells we now have. Provost, we are going to move west of the Provost field and attempt to extend that, and Link Lake, we will move north of it. Link Lake is one of the fields we discovered within the last three months.

Q Well then, may I put it this way, that half of your drilling will be drilling discoveries already made?

A Yes sir.

Q To enable a more accurate estimate of reserves to be made in that area?

A Exactly, we look at it now as a two-fold proposition, one, to discover additional areas and, two, to define the ones we have already found.

Q Well, let me ask you this,has your company ever done this sort of thing before, search for gas and develop it before there was an available market for it?

A Yes, in the San Juan Basin of Mexico and southern

Colorado, as I said before, we moved into that area when there was a small amount of gas discovered and we, over a period of approximately two and a half years by our own efforts discovered enough gas to justify the building of this line from that Basin to California, the California market, and about 95% of the gas that is moving through that line will be as a result of our efforts to discover and develop proven adequate reserves.

Q Now, Mr. Schultz, I asked you a moment ago about the money you were spending and where it was coming from and you told me it was your company's own money. As this programme expands more money will be required, and I refer now to the application which was made in September last and in which some reference was made to securing of additional capital, and I would like to ask you now, is it contemplated to give Canadian investors an opportunity to participate in this venture at the equity level?

A It certainly is. We want Canadian partners in this deal and that is the only way that we can get them, is to bring out both companies where Canadians can come in on the same basis as Americans do in participating in common stock.

Q And some such programme as that is now under consideration?

A Yes sir, we are proceeding with Canadian Delhi as rapidly as we can bring it out and we hope that Canadians will want to participate in it, it is a situation where Canadians will have to

desire to but if they do they can -

Q The opportunity will be made available?

A The opportunity will be made available.

MR. PORTER: Now, Mr. Chairman, it is planned to submit details of the route through witnesses who have engineered it, but I think that perhaps in order to found the application which was filed, to have Mr. Schultz just briefly describe the project without going into detail in the manner in which the engineering witnesses will be able to do it.

Q Mr. Schultz, can you tell us just briefly in terms of the application what the project contemplates, that is, where it is to go and what it is to do and what gas it will take to do it; the markets to be served and so on?

A The whole project, the theory of it is to take Canadian gas and let Canadians use it, very similar to the same situation we have in the United States, where our Federal Power Commission has kept American gas for Americans, and we knew in the beginning that the large concentrations of the population of Canada were in the East, just as they are in the United States. We also knew that most of the fuel being consumed in the eastern part was imported, coal from the United States and oil primarily from Venezuela for the United States. It seemed logical that if it was feasible, economically feasible to go across the shield of the country - - .

Q By the "shield", you are speaking geologically, you mean Northern Ontario?

A Yes, Northern Ontario, that could be done within an economical limit, that the gas could be sold at a reasonable price, considerably under imported

A (Cont.) coal or imported oil. That was the basis of our initial investigation.

When the preliminary reports were finished there was no doubt in our minds that markets existed in Eastern Canada, and the engineering people thought that the project could be finished within a reasonable time and at a reasonable cost, and we were already convinced that we could find gas, and that there was a substantial quantity of gas in Alberta.

Those are the three factors, and with that, we gave various companies commissions to go about and develop data of a definitive nature that we could use to convince bankers, for example, that we needed to bring into the picture. That work has not been finished, and we are more convinced than ever that it is a completely economic proposition.

Q This project contemplates a line commencing at Princess and winding up in Montreal?

A Yes.

Q Serving areas all the way along?

A In that regard it would be our purpose to serve the most communities, and we have tried, we have two situations: we tried to pick the route that would take in the largest number of communities where we could serve them over a short lateral off the main transmission line, or justify a long lateral. At the same time we have to consider terrain, so the route, it is the cheapest route and we think serves the greatest possible population.

Q You retained an organization, as I understood, to

Q (Cont.) study the market, the engineering construction problem and the geological problem?

A Yes.

Q Now, you might tell us who they were? That will be coming on later, Mr. Chairman, but it might be useful to know who they are.

A The firm we selected to do the geological study and the reserve study was the firm of Degolyer and MacNaughton of Dallas, Texas. We know the firm and have known the firm for a long number of years and know the reputation they enjoy in the United States, and it was the only logical choice.

Q Mr. Dougherty is here representing the firm and will give evidence?

A Yes.

Q That study at the geological level has gone on for how long?

A Since November, that's approximately five months.

Q Who did the engineering study?

A The Oklahoma Engineering Company, Oklahoma Contracting Company. The reason we chose that group, we felt they had more experience over a wider area and they have done a greater number of difficult projects than any other company on construction of these big inch lines, and we knew that they had participated in practically every large inch pipe line that had been built, and we needed the benefit, particularly in Northern Ontario country, we needed the benefit of the wide range of experience they had. We were not perturbed by the area from Princess to Winnipeg. We needed the very best

A (Cont.) when we were evaluating construction costs in the Northern Ontario country.

Q That survey has been underway since last Fall?

A That survey has been underway since last August.

Q The market survey was made over the territory to be served by this line?

A We had retained the firm of Ferguson and Company, and again, it is a company in the United States which enjoys a very fine reputation, and they have done a number of big jobs. They have worked with the Government in completing Government war plants and such. We had no hesitancy at all in turning this market survey over to them.

Q That survey is still continuing?

A That survey will continue, it is something that probably won't be ever finished, won't be finished, I will say, in the next year or a year and a half. It is such a big area, so many small communities and so many industrial plants. We have got the bulk of the job done, but it certainly will continue with daily supplement from time to time.

Q The same is true of the engineering examination of the route?

A We have authorized the Oklahoma Company to go forward in much more detail, a route that is tied down to a very fine detail.

MR. PORTER: I think that's all, Mr. Schultz.

MR. SMITH: Mr. Porter, we have had previously the names and order of witnesses and matters they intend to deal with, I think in this case it might be helpful to everybody.

MR. PORTER: I propose next to call Mr. Dougherty who will tender the results of the work by Degolyer and MacNaughton in the geological study. I have only twenty-one or twenty-two copies available and it runs to two volumes and they will be distributed so far as they will go. Mr. Dougherty and some of his staff who are with him will review that in the stand. The next item that I think might properly then come before the Board is the engineering examination that has been made, and the evidence of Mr. Waterfield who has been in charge of that.

Q THE CHAIRMAN: This geological study, you say engineering, you mean the engineering of the road?

MR. PORTER: The engineering of the road. This geological study deals with deliverability.

Q THE CHAIRMAN: As well as reserves?

MR. PORTER: Yes. Mr. Waterfield will deal with the physical problem of building the line, describe the terrain and tell us what the problems are and what the cost is like. I will be in a position to leave some evidence of markets, but whether that's appropriate at this time, in view of the fact that study is continuing, and we must, I think, all recognize that this hearing must await September. Whether we should proceed with that phase of the matter now is something on which I would like to reserve judgment.

We now plan to let the Board have, because it is ready and we think in good shape, the geological study and engineering study, and we may, depending on the time element, also go on

MR. PORTER: (Cont.) with the market survey. My own feeling at the moment is that it would perhaps be wiser to delay that because it is current and its value will improve as work expands.

That's the plan we thought we would follow, Mr. Chairman.

THE CHAIRMAN: Does anyone wish to question Mr. Schultz?

Q MR. SMITH: Mr. Schultz, having regard to your application, there is no written amendment?

A No, sir.

Q September, it is a long time since then, there is nothing more in writing?

A No.

MR. MARTLAND: Would it be possible to cross-examine Mr. Schultz after we get this engineering and other material? He is speaking here with regard to policy.

THE CHAIRMAN: Will Mr. Schultz be available, Mr. Porter?

MR. PORTER: Yes, there is no reason why the Board and the Counsel should not have the most complete access to both our material and our thoughts.

THE CHAIRMAN: That's fine.

THE WITNESS RETIRES.

MR. PORTER: Mr. Chairman, we have a little moving job to do. Further copies of this geological report are in the process of preparation and will be here at the end of the week. I think enough have been made to serve everyone.

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J. F. DOUGHERTY, having first been duly sworn, examined by Mr. Porter, testified as follows:

Q Mr. Dougherty, where do you live?

A Dallas, Texas.

Q And you are by profession-?

A I am a registered professional Engineer in the State of Texas in the options of geology and petroleum and natural gas.

Q You have been engaged, I understand, for the past five months, in the preparation of a report on the natural gas reserves of the Province of Alberta for the Applicant in this case.

A That's correct, yes sir.

Q And I see before you two volumes entitled "Natural Gas Reserves of the Province of Alberta" as of January 1st, 1951, prepared by De Golyer and MacNaughton. Are these the product of your effort or prepared by you directly or under your supervision?

A Prepared directly by me and under my supervision.

MR. PORTER: I would like to tender these as exhibits.

THE CHAIRMAN: Exhibit "4".

MR. C.E. SMITH: One or two exhibits?

MR. PORTER: One number for the two volumes.

THE CHAIRMAN: Yes.

MR. PORTER: Well, it may be better if we divide that number; there are over seventy fields covered in these two volumes.

THE CHAIRMAN: All right, mark them "4" and "4(a)".

Q MR. PORTER: I notice these reports bear the name of De Golyer and McNaughton. Who are De Golyer and MacNaughton? What is their business and what is

Q (Cont'd) your connection with it?

A De Golyer and MacNaughton is a consulting firm of geologists and petroleum and natural gas engineers. Our primary business is the appraisal and evaluation of petroleum and natural gas properties. In addition to that we are also supervisors and advisors on exploration and development. I am a Vice-President of De Golyer and MacNaughton and primarily in charge of all natural gas work. Our staff totals forty engineering geologists, with an additional thirty-five engineering assistants and clerical assistants. We have several resident staff geologists in foreign countries: three in Brazil and one in Mexico.

Our foreign work consists of being advisors to the Petroleum Administrations of the Republic of Mexico and the Republic of Brazil. Our men in the last six months have discovered three new oil fields in Brazil giving them a total, I believe, of seven. They will shortly embark on a program of construction of a refinery and will become at least contributory to their own petroleum needs for the first time. Our domestic work we divide into several categories. We have several governmental retainers: Mr. MacNaughton is Advisor to the Secretary of the Navy with respect to Naval Petroleum Reserves primarily in Alaska and the Elk Hills area of California. We have just completed a sub-contract from Ford, Bacon & Davis, prime contractors of the Corps of Engineers, consisting of a complete study of every gas field and oil field in the United States, designed to

A (Cont') estimate the future availability of natural gas for the manufacture of synthetic fuels in the event of an emergency. This study has taken about two years, employing the greater part of our staff most of the time. It is coming out in volumes by States, and has just been completed and will be released through the publications of the Bureau of Mines of the United States Government.

We have also supplied the Joint Chiefs of Staff a forecast of the oil reserves of the United States, and an estimate of the five year availability of oil production -- I believe it was the Joint Chiefs of Staff -- at any rate it was the Department of Defense. That was completed perhaps two years ago.

We also are retained by a great number of the major operators in the United States: Gulf Oil Corporation, City Service Oil Corporation -- in which we prepare and keep up to date the studies on their reserves annually.

In addition, at times, we have appraised the oil and natural gas reserves of every major operator, and a great number of the smaller independent operators of the United States.

Our natural gas work has been comprehensive in that we have participated in perhaps 75% of the more recent natural gas survey hearings for the Federal Power Commission. We advise the Natural Gas Pipeline Company of America who transport gas from the Panhandle and Hugoton Fields to Chicago; the Panhandle Eastern
who transport gas to Detroit and into Ontario; the

A (Cont') Trunk Pipeline Company who take gas from the Gulf coast to Detroit; the El Paso Natural Gas Company who take gas from the Great West Texas basin area to California and who are now completing their twenty-six inch line from the San Juan basin to Arizona and California. We participated -- I should say with respect to these fields which Mr. Schultz described and which were discovered through the efforts of Delhi and its subsidiaries -- I participated personally in that testimony before the Federal Power Commission in April of 1950, Certificate Proceedings which led to the granting of the Certificate to the El Paso Natural Gas Company.

We also advise on the exploration and development programs of a number of operators, a number of the larger operators in the United States, particularly in Louisiana and Texas; and at the present time we are advising the El Paso Natural Gas Company on geological studies covering their line to California and their main source areas to enable them to discover and add additional reserves to their present line.

Now, my own education consists of graduating from the California Institute of Technology as a Master of Science in Geological Sciences. After I left school I joined the staff of the Federal Power Commission in Washington as a gas geologist. I was with the Federal Power Commission from November 1939 until March 1942 as assistant gas geologist and gas engineer. During that time the Federal Power Commission was laying down its basic work having been

A (Cont'd)organized pursuant to the passing of the Natural Gas Act in 1938, and I participated in all the early work of the natural gas division, and prepared their rate cases, particularly those which went to the Supreme Court of the United States in the case of the Hope Natural Gas Company, which established the power of the Federal Power Commission with respect to rate fixing matters, and in the course of that work had considerable experience with the estimation of reserves and availability in most of the major gas fields of the United States and a number of smaller fields in the eastern part of the country.

I left the Federal Power Commission in March or April of 1942, becoming geologist for the Phillips Petroleum Company in Amarillo, Texas and at which time I was in charge of the development of the Hugoton Gas field properties of the Phillips Petroleum Company, some 250,000 proven acres of natural gas properties.

At that time I was also involved with their development program in the Panhandle Gas Field and explorations in New Mexico, Colorado, Kansas and Oklahoma.

At that same period we served as advisors in well-completion of the Natural Gas Company of Oklahoma in their properties in the Hugoton Gas Field. I have been associated I expect, in the completion of the drilling of some 750 gas wells during that whole time, and exploration for reserves and exploration for additional gas wells.

In March of 1946 I joined the staff of De Golyer and MacNaughton as senior geologist and petroleum

A (Cont'd) engineer. One year ago I was made Vice-President in charge of the natural gas activities of the firm.

This study that we have presented for the Board was prepared under my direction, with prime assistance by our senior geologist, Anthony Folger , our senior petroleum and natural gas engineer Joffre Meyer, assisted by six or eight additional geologists and engineers and a sizable clerical and engineering department staff who checked the tabulations after our compilation. We retained at the same time, through Canadian Delhi Mr. Floyd Beach to assist in obtaining basic data from operators in the Province.

The man-hours involved were approximately ten thousand man-hours in the last four or five months, of which 75% was in the technical science and engineering and geological study.

Q You made some reference to the information you were able to get from others in Alberta.

A Yes sir.

Q From Mr. Beach and from Mr. Raborn and I think it might be well to direct the Board's attention to the reference in Exhibit "4", to the sources from which that information came, the list of companies.

A I believe this is the third sheet in that section. We have listed acknowledgments to the principal persons or companies who were contacted either by De Golyer and MacNaughton or Mr. Raborn , Canadian Delhi or Mr. Beach. The extent of their presentation is quite varied, and the amount of data we received is very considerable. We found considerable interest

A (Cont'd) in contributing such basic data as could readily be released, that would not influence their current development operations.

MR. PORTER: Mr. Chairman, it was my thought that Mr. Dougherty could proceed to read the opening part of his report and highlight it as we go along, so that the picture will become apparent, and that we can then consider the extent to which at this stage we are desirous of going into the details field by field.

A I would like to make reference to the large map folded into the back section of the volume here. This is a reduced copy of the map on the wall.

MR. SMITH: I didn't hear that.

A There is a map in the rear section of the volume which will fold out. I doubt that there is sufficient room on most of these tables to allow it to be unfolded. However, it is a reproduction of the map on the wall in color, which shows our basic concept for study purposes, dividing fields into groups by their location within the divisions of the Province.

We have appended to the map or as a part of the map, an index of what we have designated as fields and prospects which have volumes of gas or were actually producing fields. They total, I believe, two hundred and twenty-seven in number, and within parentheses is the proper census designation for locating the field within the Province.

We have estimated, I believe, reserves on 70 out of 227 fields or prospects. The others have not been covered due both to limitation of time and available basic information.

A (Cont'd) I might paraphrase the introductory portion of the Exhibit. The scope of our investigation was to estimate the reserves of the Province to the extent that we could calculate them and reserves of the gas supply fields of Trans-Canada Pipelines Limited, and the future availability of the gas from those reserves in terms of net pipeline gas.

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A We have appended to the map or as a part of the map an index of what we have designated as "Field or Prospect Name", where there is a measurable volume of gas or actual producing fields, and they total, I believe, 227 in number and to the left is the appropriate census division designation for locating the field within the Province.

I might paraphrase the introductory portion of the exhibit, the scope of our investigation was the reserves of the Province to the extent that we could calculate them, the reserves of the proposed gas supply fields of Canada Pipe Lines Limited, and the future availability of that gas from those reserves in terms of net pipe line gas.

This report was made at the request of Mr. Frank A. Schultz, Vice-President of Canadian Delhi Oils Limited. The data used was obtained principally through Canadian Delhi Oil Limited, from data on file with the Petroleum and Natural Gas Conservation Board, including testimony presented in the various proceedings before the Board, and from our own files. As I mentioned, Mr. Beach and Mr. Rayborn were our agents in contacting the various operators and gathering the data. We acknowledge also the basic contribution of the Petroleum and Natural Gas Conservation Board, compilation of wells and basic geological and well data of Dr. Hume and Mr. Ignatieff in reports to the Geological Survey of Canada. I do not know the number of acknowledgments we have made here but there about two and a half pages of them and include most of the operators in the Province.

The estimate of reserves as detailed in this report were calculated by the two methods used by the industry, that is, the volumetric method involving a determination

A (Cont.) of the net feet of gas bearing porous void space within the reservoir or determined area, and the other calculation based on the decline in reservoir pressure with the accumulative production of gas or oil, the latter being primarily a performance function. Which method we used depended more on the limitations of the data than anything else and the data presently available limits the studies to the volumetric method since the incident and production of natural gas in the Province has been limited to a small number of fields supplying the local utilities. We are, however, fully convinced that properly applied the volumetric method has its very distinct place and should not be necessarily considered subordinate. In the other method, it is a matter of applying the correct factors, if they are available and proper judgment. Wherever possible we used all the reservoir date available, including drillers' log, sample logs, core analysis, and various mechanical and electrical logging devices, drill-stem tests and other tests, production histories, reservoir fluid analyses, and in the course of geological studies we prepared structural and thickness and isopachous maps, maps with cross-sections, in an attempt to limit the areas of reserve estimate and determine the volume of the reservoir. We have used this basic geological and engineering data for a basis for exercising our judgment in determining the appraisal and estimating the economic recovery of gas from the various reservoirs. We took particular care to reduce volume of gas reserves in place to recoverable gas reserves at the well head by taking into account both reservoir losses and surface losses. You will note in our tables that we refer to gas remaining

A (Cont.) at a "terminal" pressure or "terminal" conditions rather than "abandonment". We have never liked the term "abandonment" because that has a very final sounding, is a very final sounding name. In many cases it does not mean abandonment, it is just a stopping place on the way towards ultimate abandonment and it is determined by the economics of the particular field at a particular time in the future. Most of these gas reserves as estimated will produce substantial volumes of gas beyond the terminal conditions we have cited. In most cases our estimated terminal condition will be in excess of 200 pounds bottom hole pressure and will range upward to 700 pound depending upon the reservoir and the particular conditions. Surface losses considered have been field waste, field fuel uses, compression, shrinkage, deductions, to arrive at the volume of gas available at the well head. We are of the opinion that the actual waste will be negligible in the future when the value of gas at the well head has been realized, and, along with the surface methods employed, promote utilization of much of the gas which is now flared or blown into the air due to the lack of a market outlet. Our experience in the United States has been that once price enters the picture, that waste becomes a very minor problem if there is a market.

The most difficult part of the study was the classification of our reserve estimates. At this stage of the development of the Province it is obvious that what is normally considered proved reserves is but a minor portion of the gas which will be available due to future development and the exercise of some geological and engineering imagination. We have divided the reserve estimates into

A (Cont.) "proved", "probable", and "possible". These definitions do not correspond with any definitions I believe, previously considered by the Board, although we have adopted and do agree with Mr. Liesemer's definition that "probable" reserves by definition are essentially proved, and as such we so consider them, being merely a slightly lower category of "proved" reserves.

MR. McKINNON: You say that is Liesemer's definition?

A Yes, sir, I believe in his submission he proceeded to define according to Webster's Dictionary what "probable" means and that essentially it was "capable of being proved or proved", and as such we have so considered it. The definitions we have employed I do not care for particularly, to attempt to define them. We found implications and inferences that one would like to append to definitions until they become so voluminous that when we get through the definition is almost meaningless, so that we have limited it to a very general definition on the eighth page of the introductory portion of the exhibit and I believe I will read those although I think their full import will only come by examination of their usage in actual fields and they vary within the field.

"Proved Reserves Reserves proved for oil or gas production in the given reservoir by actual well tests, either in the cased hole or by definitive open hole drillstem tests. These reserves are defined areally by reasonable geological interpretation of structure and known continuity of oil or gas saturated reservoir material above limiting water saturation.

A (Cont.)

"Probable Reserves These reserves, considered as essentially proved or capable of being proved, are defined by less direct well control but are based again upon evidence of producible gas or oil within the limits of a structure or reservoir above inferred or known water saturation.

"Possible Reserves This category is similarly determined but may be based largely upon electrical log interpretation, or widespread evidence of commercial gas saturation defined by widely spaced test wells. It may also include areas of geophysical anomaly that are immediately adjacent to proved productive areas of like geophysical character."

For the estimation of projected performance, that is the rate at which these recoverable gas reserves available for sale can be produced from the well by reservoirs were made in accordance with the usual methods involving the application of the gas laws, Boyle's law and Charles' law, and the methods of calculating back pressure open flow potential as employed by the Railroad Commission of Texas, Oil and Gas Division, and the various publications of the Bureau of Mines, particularly their Monograph Number 7, and various other pertinent studies involving the flow characteristics of wells and reservoirs. Wherever back pressure test data was available we used it or other available test date to estimate the open flow capacity of the average well in the different reservoirs.

The amount of data on open flow capacity is limited but we feel that the figures based upon other tests are realistic and represent the probable average open flow for

A (Cont.) a given field. We have not deviated far from what can be depended upon as realistic at this stage.

We have assumed the absence of water drive in almost all cases in these studies. There may be some encroachment in a few of the fields which might influence the usual decrease in open flow capacity that results from depletion of the reservoir and perhaps makes the decrease in open flow capacity a little less marked than indicated in our calculations.

The matter of the rate of completion of wells is, of course, somewhat arbitrary, to estimate the number of wells that a given operator will complete in a given field in a given length of time, and it cannot be determined, but we have treated that on the basis of usual development rates and they are conceived as being minimum rates rather than maximum rates of development, that would occur under the stimulus of having a market and having the probability of being able to sell their gas at the well head.

I made summaries with respect to the reserves of the Province of Alberta of those fields or prospects that we were able to estimate in the length of time and with the data available. We have estimated that the proved reserves in the Province total 8,169,943 Mcf. These volumes are expressed at the base pressure of 14.4 psia or pounds per square inch absolute, and sixty degrees Fahrenheit. We estimate "probable" reserves as being 2,224,278 Mcf. The total of these categories, "proved" and "probable" is 10,394,291 Mcf. and the "possible" aggregate is 2,277,365 Mcf. In our studies of gas available for sale we have not utilized any of the reserves considered as "possible".

MR. SMITH: Excuse me, Mr. Dougherty, what page is that you are

MR. SMITH: (Cont.) referring to?

A That would be the page headed "Summary and Conclusions", it would be the third page before the tab sheet called "Provincial Reserves", it will also appear on that sheet. However, it is conveniently set out in the third sheet before the tab designated "Provincial Reserves".

MR. SMITH: Thank you.

A The total volume of gas we estimate as available for sale after deductions for reservoir losses and surface losses is 7,878,498 Mcf. That form of gas deferred by oil production is 429,621 Mcf. That particular reserve is primarily in the D.3 gas cap in the Leduc field.

DR. GOVIER: This 7,878,497, you say that was from the "proved" and "probable"?

A From the "proved" and probable", yes, sir, after deductions for surface losses, reservoir losses.

After that we have a summary of recoverable natural gas reserves of the proposed gas supply fields of Trans-Canada Pipe Lines Limited, and in the "proved" category we estimate 3,610,027 Mcf. In the "probable" category we estimate 1,528,741 Mcf, making the total "proved" and "probable" 5,138,768 Mcf. The "possible" is estimated at 1,443, 272 Mcf. From the "proved" and "probable" we estimate that the volume available for sale at the well head is 4,265,768 Mcf.

Those reserves are primarily non-associated, that is, not associated with an oil column in the reservoir, dry gas so-called or gas condensate.

The next summary sheet gives a brief summary of the estimated future availability of pipe line gas to Trans-Canada Lines Limited from the proposed gas supply field,

A (Cont.) the previously estimated proposed gas supply field. We estimate in the first year of operation the net average delivery of gas would approximate 221,000 Mcf. per day. In the drilling program we have estimated it would require 146 well or sand completions. The deliveries then build up as well development progresses under our estimate to an average of 291,000 Mcf. a day in the second year. If under the impetus of having a market for gas the operators drill their properties up to the maximum in a short period of time these deliveries would be very substantially increased and would only be limited by the maximum development of the field which we have not considered here. We have considered it and this is based upon a moderate, realistic, minimum drilling rate, and in that fifth year the daily average net gas delivery would approximate 388,000 Mcf. per day. By the tenth year it would decrease slightly to 365,500 Mcf. per day, that is, on the assumption of no additional fields, that no additional fields are brought in and no additional gas has been discovered in Alberta that could be tied into this line. This would assume only depletion of "proved" and "probable" reserves as presently estimated. The delivery rate would continue a decline as the reservoir were depleted through the fifteenth, twentieth and twenty-fifth years.

We have estimated that the average delivery rate under our drilling program for the first five years would yield a delivery rate of at least 325,000 Mcf. per day and it could be half again that much depending upon the rate of development of the fields. The tenth year would average 347,000 Mcf. per day. The fifteenth year would average 327,000 Mcf. per day. The twentieth year would average

A (Cont.) 300,000 Mcf. per day and the twenty-fifth year would average 282,000 Mcf. per day.

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Following the introductory submission we have summarized your census divisions. The Provincial reserve, that's behind the tab sheet entitled "Provincial Reserves". You will note that with the exception of census divisions nine, fifteen and seventeen we have estimated some fields within each census division. 17 is the North eastern most census division in the general Wabiskaw Lake area, which we didn't estimate reserves even though there is considerable gas saturation, because of their inaccessibility and the general high cost of development.

Census division 9 includes that division north west of Calgary, marked by the present Brazeau field, Foothill's structure, and there has been insufficient data to estimate even approximately what the cost might be, although we are convinced that some of the northern Foothill structures are going to produce substantial amounts of gas, and they will require the investment of substantial amounts of capital.

The census divisions having the greater part of the reserves, census division 2, which includes the Pincher Creek field; census division 3 which we have, which includes Princess and Medicine Hat fields; census division 11 which takes in the Leduc area. Census division 14 which takes in Cardiff, Legal, Morinville area and Redwater. Census division 16 which includes the division that comprises the fields of Pouce Coupe and the Whitelaw discovery.

The next breakdown is the reserves of Trans -Canada Pipe Lines Limited, that is, the reserves of the proposed supply field of Trans-Canada Limited.

Q MR. PORTER: I think perhaps at that stage I might intervene. You were describing those as the proposed supply fields. Do you mean that there is no intention to go to other areas for gas for this line?

A This is our proposed supply field for the initial program.

Q For the initial program?

A As they exist now. Obviously a trunk gathering system of magnitude will traverse the Province from the south-east to the north-west, through the heart of the developed area so that you can have ready access to any fields, gas cap wells that may come in the future. It is based only upon reserves estimated in this report. We have indicated that the area enclosed by census division 15 which lies between Leduc, Redwater and the Pouce Coupe - Whitelaw area in which the North Tangent Well developed recently, publicized by their blow-out, offers great promise of development and very large volumes of gas reserves. We can not estimate the reserves or the even possible reserves for that census division because of lack of data. It has not been released by the operators. These may yield very large volumes, and we contemplate an extended trunk gathering line from the Morinville area to Whitelaw.

A (Cont.) In census division 16, it would transverse that area and offer inducement to development and marketing of gas in what is a relatively inaccessible area, one involving some cost in development.

The proposed gas supply field of Trans-Canada Limited will encompass eight census divisions, numbers 2, 3, 5, 7, 8, 11, 14 and 16, roughly a line south-east - north-west through the Province.

Q That's your initial area?

A That's the initial proposed trunk gathering system.

THE CHAIRMAN: I think we might adjourn now for about ten minutes.

(At this point the Hearing stood adjourned for fifteen minutes and reconvened.)

THE CHAIRMAN: It seems to the Board that there is not very much gained in having Mr. Dougherty proceed to high light this exhibit at the present time until we have had an opportunity of studying it. We would like to have the comment, though, of the other Counsel before we make a decision of adjourning. We would also like to know, Mr. Porter, if you are in a position to distribute other exhibits which you intend to file?

MR. PORTER: I intend to distribute the exhibit with respect to the engineering work, and the witnesses to support them are here. I had some discussion with some of the Counsel in the intermission, and the suggestion came forward by some of them that we must again return to this subject in September, that it might be acceptable if Mr. Dougherty continued to high light his exhibit to a point where we would

MR. PORTER: (Cont.) understand his approach, and then if we might adjourn the cross-examination of that exhibit until the September Hearing when it would be supplemented by the developments between now and that time and be dealt with as part of the whole examination or re-examination which the Board will no doubt have to make at that time. That contemplates an adjournment to September. If the September adjournment were in mind, then Mr. Dougherty could finish to the Board's satisfaction, describing his methods, so that you will have a basis for study for the summer and I could then put on the engineering evidence, and it, I think will probably be subject to some study and examination in the Fall as a result of the more detailed study which is continuing and will continue until the September Hearing.

We are in the Board's hands insofar as those two items are concerned. I would rather consider again for my client, whether we want to go on with the market survey, which, as I said at the outset is still in process and perhaps it will be more usefully submitted later on when more work has been done.

THE CHAIRMAN: Any other Counsel like to discuss their opinion?

MR. CHAMBERS: I think we all agree that the Hearing would be expedited and time saved if Counsel had available the material that is to be represented from time to time, in advance of the Hearing, and this is no reflection on my friend for not having it at this date, I am thinking of the future. What I had in

MR. CHAMBERS: (Cont.) mind would be that if we could get this information before us now and time would probably be saved by the questions being sifted in the meantime and have the cross-examination in September or when the Board decides to meet again. I also have in mind that my friend would probably have other information or reports prepared during the summer as his investigations progress, and if the arrangement that had been followed before, that is, as soon as they are available, they are distributed, so that when the Board then meet again we are prepared to go ahead.

MR. STEER: My interest, Mr. Chairman, as you are quite well aware, is that the Board should determine in the first instance what amount of gas is required to meet the demands of the Province over a specific period of time, whether it be thirty years or forty years as originally announced, and the suggestion that has been made appeals to me as an entirely reasonable one and I think that the Board should consider perhaps a further inquiry first of all into available reserves and future demands before looking into the merits or the demerits of any particular scheme. My suggestion is that the Board might perhaps consider a reopening of the Inquiry that was held that Fall on the question of reserves specifically in the light of information that is available since that time.

THE CHAIRMAN: You mean, Mr. Steer, reserves, deliverability and market requirements in the Province?

MR. STEER: Yes. There has been a great deal of

MR. STEER: (Cont.) information made available since the Hearing last Fall, as the Board knows, as to what future demands in this Province are to be, and it may be found that the quantities which the Board thought would be required for Provincial requirements are quite too low.

MR. McDONALD: I agree with the Board that we should have enough explanation from the witness so that we can understand exactly what he did in arriving at the totals he has given us here so that we can compare them with the submissions that had been made by other geologists. I think the Pincher Creek field, for instance, or one of the lower cretaceous fields would be sufficient for that purpose, and I would like to see him do that. At the same time, I haven't had an opportunity of really looking into it. There may be some questions I would like to ask bearing on that particular point, of how he arrived at this estimate. With regard to the reopening of the Inquiry that we dealt with last year and which was so ably dealt with by the Board, I can't agree with Mr. Steer, I feel that if we are ever going to arrive at a decision in this matter, we should proceed with the individual applications as and when they are prepared to deal with them, and in case any additional information with regard to future demand or future requirements of the Province and the future supply is available, to take care of it, and then we deal with specifically each individual application.

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MR. CHAMBERS: Apropos of what Mr. McDonald said, my understanding was that the announcement the Premier made some time ago was that the whole matter had to be looked into again in the light of now changed circumstances; in other words I understood that there was an implied understanding that the whole matter of reserves and the requirements would be up for reconsideration in September.

THE CHAIRMAN: Certainly, when the applications do come up again in September, opportunity will be given for representations in connection with requirements, and the Board will consider the requirements as they are at that time or as we see them at that time.

MR. C. E. SMITH: That is what was said in the report, Mr. Chambers.

MR. CHAMBERS: Yes.

MR. SMITH: I don't know, Mr. Chairman, just what counsel are agreed on with respect to our present sitting here but it strikes me that in view of the quantity, for instance, of Mr. Dougherty's submission, that there isn't very much use of going on today by way of highlighting it, because personally if somebody is going to highlight something I would like to have a look at it first and then I will understand something about it. I don't know whether an adjournment of two or three days now would be of assistance. Has anybody thought of that? Say until Thursday? Did I understand Mr. Porter to say we had Mr. Waterfield's written submission available now? And was that what was intended to be submitted with Mr. Dougherty's submission?

MR. PORTER: Yes, but it isn't nearly as voluminous.

MR. SMITH: I wonder, sir, if counsel would remark on the idea of whether or not it might be an advantage to everyone concerned to adjourn this right now until say, Thursday, with respect to Mr. Dougherty's submission, and then re-assemble then.

MR. MCDONALD: I suggest we adjourn until tomorrow morning; then we could dispose of both witnesses tomorrow and adjourn the hearing until September.

MR. PORTER: I had in mind that Mr. Dougherty might now describe his Exhibits in such a manner that the technical advisors of the Department and the Board would be approaching them from a common standpoint when they were examining them. Now, whether it is useful for them to do that after a short adjournment or now, that is a matter for the Board. Those documents are prepared at a technical level and certain approaches are made which ought to be common to the minds of all examining them. I thought it might be useful for Mr. Dougherty to say how he arrived at the documents and estimates just so that everyone might understand what they mean.

MR. CHAMBERS: My specific suggestion is in line with Mr. Porter's: that Mr. Dougherty and the witness who is to put in the engineering exhibit, might give their evidence in chief, and let the matter stand until September for their cross-examination.

THE CHAIRMAN: The Board feel they would like to adjourn until Wednesday to hear Mr. Dougherty. In the meantime he could give us one or two typical examples, and on Wednesday he could highlight the exhibit.

(The CHAIRMAN CONT'D) We would like some time to just go over it now. Now, if you wish to, Mr. Dougherty could proceed just now, and if you wish to put anybody else on today, if there is sufficient time, we can. If not, then we will adjourn.

MR. PORTER: I am just wondering about this: we could distribute the engineering exhibit and I wondered if we might go on with that in the morning, and then the technical men can be having a look at Mr. Dougherty's submission against his going on Wednesday; or does the Board feel they would like tomorrow as well to have an opportunity to examine this exhibit before Mr. Dougherty deals with it.

THE CHAIRMAN: I think we would prefer to have tomorrow. Have you any exhibit prepared now showing your estimate of the provincial requirements, or do you intend to deal with that?

MR. PORTER: Not at this stage.

THE CHAIRMAN: But you will if we adjourn to September?

A Yes; there wasn't sufficient interval between the Board's finding and the present time to gather enough material which would either increase or diminish the estimate of the Board. By September that information should be more readily available, and my clients will submit at that time what, after all, will only be their opinion.

THE CHAIRMAN: Mr. Dougherty may proceed now to give us one or two typical examples of how you arrived at your reserve estimates.

A In the Census Division 1. -- if you gentlemen will refer to page 18 and also page 21 -- page 21 is a

A (Cont'd) map which can be pulled out away from the printed matter so that it will be readily available -- page 18 is a reserve estimate sheet of the Pendant d'Oreille Field, Estimated Natural Gas Reserves, Bow Island Sands. Page 21 is an isopachous map or equal thickness map of Bow Island net gas sand in the Pakowki Lake area in which the Pendant d'Oreille Field is the long slender field traversing the centre of the map exhibit, and joins the foremost field at the upper right hand corner.

Now, the reserve sheet is the same on any non-associated gas reservoir for each field in the exhibit. We have the line number to the left and then we have a series of items which gives the factors which we have utilized in the calculation. The first item is the type of gas -- in this case non-associated with oil, that is, dry; specific gravity; heating value per BTU/Cu Ft; estimated productive area, acres proved -- in this case 80,471, which is derived by planimetering, that is, measuring the area; the estimated thickness in acre -- no, the estimated average thickness in feet, which is derived by weighting the area of each contour -- each of the contour thicknesses contained on 21 by area, taking the total of those factors and dividing by the total area to arrive at a weighted average thickness, that is, if the sand were spread uniformly over the designated proved area. That composite volume appears on line six as seven hundred and sixty thousand some odd acre-feet of floor space. Item seven is the estimated porosity in percent, in this case twenty four point zero, and it is derived from the core

A (Cont'd) analyses and electrical logs, submitted by the McColl-Frontenac/Union Group. Item eight is estimated interstitial water, or connate water -- line eight derived from the same source, by the restored state method of determining connate water for particular thicknesses of porosity designated as average net thicknesses -- these factors being applied to the particular average thicknesses of net sand derived from the isopachous map.

Line nine is the estimated initial reservoir pressure in pounds per square inch -- a measured quantity determined by the measurement on certain wells.

Number ten, terminal reservoir pressure -- in this case it is one hundred pounds per square inch absolute. That determines the pressure to which we expect the reservoir to be depleted by pipeline deliveries and that represents approximately eighty-five to eighty-six percent of the gas in place.

Line eleven, estimated reservoir temperature in degrees Fahrenheit, a measured quantity.

Line twelve, estimated compressibility factor at initial conditions -- in this case zero point eight nine, derived from both gas analyses and from a study of curves relating the division of natural gases from the compression gas loss in relation to pressure and temperature.

Line thirteen is the estimated compressibility factor to be applied at the terminal reservoir conditions -- point ninety-nine.

Then, the initial gas in place per acre-foot,

A (Cont'd) fourteen, is derived by applying these factors previously recited in the usual volumetric formula relating square feet an acre to porosity, connate water, pressure, temperature and the deviation of the gas from perfect gas laws.

The sum of the factors calculated for the remaining gas in place per acre-foot is line fifteen.

Line sixteen gives the result of cross-multiplying line fourteen (initial gas in place per acre-foot) by line six (estimated reservoir volume), and that yields the total volume of the initial gas in place, in this case, three hundred and fifty-five billion feet.

Seventeen is derived in the same fashion: line fifteen cross-multiplying/by line six, and estimated here at 42 billion.

Line seventeen, total remaining gas in place at terminal pressure,is the gas remaining in the reservoir at the terminal pressure of a hundred pounds per square inch absolute.

Line eighteen: subtracting those two, that is, the total initial gas in place and the total remaining gas in place at terminal pressure at the well-head, three hundred and thirteen odd billion feet.

Line nineteen is the estimated cumulative production to January 1st, 1951. We have no figures. There has been a little gas used testing in some wells, to a negligible quantity as far as we could determine.

Item twenty would be a subtraction of the cumulative production from the initial recoverable

A (Cont'd) gas to terminal pressure, line eighteen.

Line twenty-one is the estimated field and fuel uses, which include the ordinary field losses. In this case we assume that at first there wouldn't be any compressor fuel taken out at this stage. We do actually group the entire Pakowki Lake area as being a unit gathering property, and in our summary sheet on availability we deduct the compressor fuel from the gross field production -- that would appear on another tabulation. However, usually this estimated field and fuel uses include the compressor fuel at a percentage of four or five percent -- I will say, rather, usually these estimated field and fuel uses -- line twenty-one -- include four or five percent of line twenty for compressor fuel. This volume is usually sufficient to compress the gas from the operating pressures to the pipeline pressure: usually one or two compressions. We don't know at this time just how the operating pressure will function, but we have taken enough fuel, taken into account enough fuel so that compression could be used by the main gathering line.

Line twenty-two is the estimated shrinkage losses at two percent. That is due to the shrinkage of the slight amount of liquids contained in the reservoir under reservoir conditions as compared with surface conditions.

Twenty-one and twenty-two were deducted from the estimated remaining recoverable gas to terminal pressure -- line twenty.

A (Cont'd) Line twenty-three is the estimated recoverable gas reserves available for sale; in this case, approximately three hundred and six odd billion cubic feet.

These same forms were used for all non-associated gas reservoirs, and those same factors are then applied to the other categories, probable and possible, if they are so designated.

Now, these areas shown here were in this case determined by the examination of all the well data with the consideration of this map page twenty-one.

We have structural data behind this exhibit which we haven't printed in this volume because of its size. This represents our best judgment of the limits of the reservoir with the data presently available. On the reverse side of the sheet, that is page eighteen we have shown the projected performance of this field from those reserves, the reserves of which have been previously calculated on the front part of the sheet.

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A The data shown here is for annual increments to twenty-five years. The first column is the net annual gas deliveries. The second column is the required annual gross gas production at the well head to which we took off various allowances for shrinkage, and if we had assumed that this field would perform on its own without being considered along with other fields in the Pakowki Lake area on a common trunk gathering system, we would have deducted at this point also compressor fuel. However, as I mentioned before that was deducted for a group of fields and will probably be sour gas from Black Butte field which could be readily used as compressor fuel and would not contaminate the pipe line gas. The fourth column is the cumulative gross annual gas production at the well head required for the net annual delivery shown in the second column. The fifth column is the daily average net gas delivery which is calculated from the relationship of the decline in the reservoir pressure, decline in open flow capacity in order to stay below 25% open flow capacity on the average. The sixth column is the daily average gross gas production, the data being that shrinkage volume shown in footnote (A). Column 7 is the number of wells required to make that delivery under the particular pressure and open flow conditions at the particular stage of depletion in the reservoir as determined from the relationship between the pressure volume factor of the reservoir and the declining productive capacity of the wells on the back pressure open flow curve. We have ample wells here to take care of the delivery capacity required.

Column number 8 is the average shut-in wellhead pressure at year end which is derived from calculations

A (Cont.) involving the depletion of the reservoir from initial pressure.

The ninth column is estimated total open flow capacity at year end, that is the open flow capacity against atmospheric pressure determined from the back pressure curve and the pressure volume constant for the reservoir.

The last column, column 10, isthe estimated total delivery capacity against 613 pounds per square inch absolute at year end per day. This is in effect the well head working pressure. We feel that initially the production, a well produces into a gathering system at 613 psia or up to whatever pressure the line was operating at the gathering system, and in this area we visualize the production as being at the operating wellhead pressure to a main trunk compressor station which would then take that composite delivery of gas at its average line pressure and compress it, compress the whole volume of the production of this group of fields to the required pipe line pressure and we made appropriate deductions for compressor fuel out of the total volume.

As you will note by the subscripts, (B), (C), (D), (E), and (F) that as the field is depleted either delivery pressure is reduced approximately at 100 pound intervals from 513 to 413, to maintain the delivery capacity required under the daily average net gas delivered in column 5, or the alternative would be to compress the gas up to the line pressure, that being something that would be a matter of operations. You will note under the estimated number of wells, column 7, that we reach a maximum of 34 and then begin losing wells so that in the

A (Cont.) last five years it is 32, 29, 25, 21, 19, and 18. We base that upon experience in some of the adjacent Bow Island fields where there was a slight watering up of the edge wells and as it is shown in this case we have made this prognostication before checking with Bow Island performance and not having reached that stage in our calculations, but we found that we had arbitrarily reached almost the same percentage of wells that had been experienced at Bow Island. That will actually depend on the manner of operation and we are convinced through examination of a number of the fieldsthat have been operating that operations could be considerably bettered and that with the higher price for gas and with production and technique, will allow the drilling of fewer wells to maintain a given rate.

DR. GOVIER: I wonder, Mr. Dougherty, if I might ask one or two questions before you go ahead there?

A Yes.

DR. GOVIER: On Table (8) of your page 18 you apparently have made no deductions for reservoir loss in excess of a theoretical reservoir loss; is that a practice that you have followedthroughout in the case of non-associated gases?

A Except for the loss in the wells, that is true, because we do not expect that a prudent operator will produce water logged wells, he will block them off and allow the water encroachment to move the gas up to a higher structural line. With that concept of reservoir loss on that basis, it would represent a very small percentage in a well operated field.

DR. GOVIER: And on the other page, over on the other side of page 18 where you give column (7) estimated number of wells,

DR. GOVIER: (Cont.) is that based on the total "proven" plus "probable" area or just on the "proven" area?

A That is on the "proved" and "probable".

DR. GOVIER: "Proved" and "probable".

A "Proved" and "probable", and the wide spacing, I think on the average, I can dig the detail out, about a thousand acres per well. We think that closer spacing can be a cushion for additional development on a deliverability basis and also on the matter of operation and delivery capacity per well could be maintained at a higher rate at a larger spacing, utilizing more of the pressure for each well. We have never approached 6.4 actually in any of the calculations.

DR. GOVIER: I wonder if you would elaborate a little bit on the relation between column (10)and column (9)?

A Column (9) is the estimated open flow capacity under bottom hole conditions, the usual Bureau of Mines back pressure curve showing open flow capacity against back pressure; but column (10) is the wellhead working pressure curve.

DR. GOVIER: It is the relationship between the two?

A One is bottom hole pressure and the other is wellhead capacity curve.

DR. GOVIER: Do you use any fixed ratio between these two, or do you arrive at column (10) by giving some kind of consideration to column (9)?

A It is derived directly from column (9).

DR. GOVIER: On what basis?

A From the, relating our average open flow capacity curve to the equivalent open flow curve at wellhead conditions, using wellhead operating conditions instead of bottom hole operating conditions, it would be an approximately .85

A (Cont.) curve with a smaller pressure pc squared minus pw squared (the well head working back pressure curve), relationship to get the actual wellhead working conditions.

DR. GOVIER: Just scanning the figures it seems to me there is no constant ratio between the figures in column (10) and those in column (9)?

A Well, there could not be because as new wells come in, they come in as we drill at a higher pressure than wells where there has been depletion so that their percentage to open flow capacity would vary and the resulting curve is a composite of new wells at original pressure or approximately original pressure in the early stages and wells that had a pressure depletion.

DR. GOVIER: Have you assumed a non-uniform pressure decline in the field then?

A Yes, sir, in most cases because that only would occur in the first, say, five years, as the development progresses obviously the entire reservoir could not be brought into pressure equilibrium with that many billions of cubic feet in that short time, some of the edge wells would be at a higher pressure, they would be brought in at one end or the other end of the field.

DR. GOVIER: I take it, Mr. Dougherty, in the fourth year you show some 27 wells, you know that of that 27 probably eight of them are near the edge and that those eight would be at a higher reservoir pressure, is that the general approach you have taken?

A Yes, if I had the working papers here I could give you the exact detail.

DR. GOVIER: Well, I do not think it is detail, detail is not necessary, it is the method I want to get.

A That is the general way, we had this all detailed and if you wish we can supply you with some greater discussion on that.

DR. GOVIER: We may want to question you further on it, Mr. Dougherty, but I do not believe we want full detailed working papers.

A I see.

DR. GOVIER: Perhaps you might clarify just a little further, though, for me; I notice for example in that first year column (10) represents 23 or so percent of the figure in column (9)?

A Yes.

DR. GOVIER: Whereas in the, let us go down, the year 19 or 20, I guess it is year 20, the entry under column (10) represents some 75 percent of the entry under column (9). Could you comment on that wide difference between 20 to 25 percent at the beginning of the table and some 75 percent near the end of the table?

A Well, the percentage of the total open flow capacity is higher in the later years than it is in the earlier years.

DR. GOVIER: Why?

A Because we have fewer wells at a depleted pressure and we are utilizing more of the open flow capacity for that pressure differential involved between the reservoir and the wellhead.

DR. GOVIER: Well, did not you assume that there would be some restriction in the percentage of open flow capacity which could be utilized?

A Yes, I think if we relate, you see these are total figures and not average, if we relate the per well average open

A (Cont.) flow, we have, say, approximately 21 wells, let us get a number we can divide easily, I say 21, 21 wells in the 23rd year and the daily average net gas delivered is, or the gross gas delivered is fourteen million on 21 wells, it is about 700,000 plus or minus per day per well, and our total estimated open flow capacity at the year end in that case is 31,900 Mcf, we are talking approximately, and we are taking some place slightly under 50% of the open flow capacity at the tail end of the life of the field. It is our concept that the wells will in effect produce as if they were just floating against the given line pressure, so that they can produce at the very end of the life of the field, in the earlier life where there will be more data at a high production rate, the open flow percentage is kept down. We have found that to be a very common experience in producing gas fields. Those conditions will vary throughout the exhibit shown here depending upon what we have as local conditions and the local reservoir conditions.

DR. GOVIER: I am still unable to reconcile the figure of 59,200 Mcf. with the figure of 75,200 Mcf which are the two entries in Column (10) and (9) for the year 22?

A I expect I will have to get our working papers and verify that completely.

DR. GOVIER: You might help us on that later, Mr. Dougherty?

A I will be glad to.

DR. GOVIER: Thank you. Would you like to go ahead now?

A Yes, sir. If you will refer in Volume 2, Census Division 11, page 21, the sheet page 21 is the Golden Spike field estimated natural gas reserves, dissolved gas reservoirs. This form is slightly modified for taking into consideration the production of gas that is dissolved in the oil

A (Cont.) in the reservoir. The same general type of form follows. There is a line on the left of a series of items, factors employed, and column (2) are the items, and the units of those factors is column (3), and then the factors for the Nisku (D.2) Dolomite is column (4) for the "proved" category. Starting out, line 1 is the type of gas, dissolved. Line 2 is the estimated productive area in acres. That is derived from the isopachous map, page 22, of the Golden Spike field, showing the thickness and gross oil saturation. Line 3 is the estimated average thickness and line 3 is derived from applying a percentage factor to the gross thickness to reduce it to net thickness of effective oil bearing porosity. Line 4 is estimated reservoir volume in acre feet derived from weighting the perimeter areas of the average thickness of the individual areas to arrive at the full average thickness or the total acre feet. Line 5 is the estimated average porosity in percent, 9% derived from core data, or correlation with core data wherever it is absent, and in this particular case I believe we have assumed that the D.2 reservoir core analysis data of the adjacent Leduc field. Line 6 is the estimate interstitial water factor percent, and these factors also derived from the Leduc field./ Line 7 is estimated oil shrinkage factor derived from laboratory data and/or correlation with Leduc data to reduce reservoir barrels to stock tank barrels. Line 8 is estimated initial oil in place per acre foot in stock tank barrels which is derived by applying the volumetric calculation involving barrels per acre foot times the acre feet of porous space multiplied by porosity of connate water and the shrinkage factor to convert it to stock tank barrels. Line 9 is the estimated

A (Cont.) initial dissolved gas-oil ratio, derived from laboratory data available or estimated from a similar type oil in adjacent reservoirs if it has been measured there.

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A (Cont.) (10) estimated initial dissolved gas in place per acre foot, is converting our acre feet of gas in place to dissolve gas in place per acre foot by multiplication of items 8 and 9.

Line (11) estimated dissolved gas factor in percent, in this case 85% applied to the quantity in line 10, to obtain line 13.

Line (12) estimated initial recoverable dissolved gas per acre foot, reduction from 294 Mcf per acre foot to 250 Mcf per acre foot, for what we conceive to be an essentially depletion dry field. We have intended to use that factor for a depletion type reservoir in view of the absence of any concrete studies of experience in similar reservoirs in the United States, known reservoirs here haven't progressed sufficiently far to obtain it directly, but that would involve essentially recovering 100% of the gas dissolved in the produced oil which was brought to the surface; then recover an average of 75 to 85% of the remaining gas in residue oil in the reservoir by reduction in the reservoir pressure. The total being approximately 85% of the stock tank oil in place. The multiplication then of the quantity 250 Mcf per acre foot on line 12 by our line 4, estimated reservoir volume per acre foot gives the line 13, total initial dissolved gas - - I used the wrong quantity there, to derive line 13 total initial dissolved gas in place cross multiply line 10, 294 Mcf per acre foot, by line 4, estimated reservoir volume acre foot. The initial recoverable dissolved gas, line 14, is cross multiplied by

A (Cont.) line 12, initial recoverable dissolved gas per acre foot, by line 14, the estimated reservoir volume in acre feet.

Line 15 is the estimated cumulative gas production, January 1st, 1951, if there has been any, and it is estimated in the case of D2 at Golden Spike, it is still non-producing, very small volume, if any.

Line 16, this would be subtraction of 15 from 14.

17, we have come to estimated field, fuel and waste. We have assumed that, in this case, that it is essentially 100%, or exactly 100% of the available dissolved gas recovered will be utilized for field purposes. It is relatively small in volume and will either be used as fuel, or perhaps will be saved and utilized with additional make-up gas from other reservoirs if recoverable operations are utilized, but, in effect, we have said here that there is none available for sale.

Now, there are other tabulations in which, where the volumes were large and we felt the likelihood of there being some differentiation between fuel, waste and use of the total volume, the residue would be available for sale. Where we have associated gas reservoirs, that is, gas caps, we have used the tabulation which is similar to the first non-associated gas tabulation.

This carries us down to the point of dissolved gas recoverable. Then we have combined in a small sheet, associated and dissolved gas for the unit reservoir, for example, we might look in census

A (Cont.) division 11, page 38, the Leduc-Woodbend field. This page is similar to the form used of non-associated gas since we compute the form of gas in the gas cap above the D3 oil, and we carry that down to the estimated recoverable gas available for sale. Since we have conceived the Leduc D3 reservoir as being a full water drive reservoir, is that the required pressure will never drop below the saturation pressure, and that the dissolved gas producible will only be dissolved in the oil produced at the surface, that none of the residue gas will effectively come out of the oil reservoir, and then depletion of the overlying gas cap will take place essentially as a gas reservoir under water drive conditions to an eventual depletion which would approximate about 90% of the gas in place in the D3 gas cap, by the action of the water drive.

You note that we have made deductions in line 19, page 38, for estimated field and fuel losses, shrinkage and waste, leaving a residue in line 20 which could be sold or utilized outside the field if appropriate capital investments were made to gather and dispose of it.

On the next page is an Isopachous map, page 49, of the D3 gross gas saturation. Following it is the dissolved gas calculation sheet for the Leduc D3 reservoir which we have discussed on Golden Spike.

That covers the general type of calculation sheets and tabulations submitted.

Q THE CHAIRMAN: Could you give us an example of a

Q (Cont.) partial decline?

A Yes, I believe in census division 3, page 11, Medicine Hat field and the following map, page 12 is an Isobaric or pressure map of the Medicine Hat and Redcliff field.

On page 11, this is estimated natural gas reserves, Medicine Hat Sands. We attempted to compare the pressure decline calculation with a volumetric calculation in this case since Medicine Hat is nearby the Pendant d'Oreille. Since the fields are close together and the sands are in the same general geological section. We attempted to apply the factors in the Pendant d'Oreille field in volumetric calculation to see how we compared with a pressure decline calculation. The first half of the sheet is a volumetric calculation utilizing the porosities of the Pendant d'Oreille field and connate water and the usual pressure factors. The second half of the sheet is one we have called the Equal Pound Loss Method, for lack of a better name. Relating to the formula shown at the top of the page, that is, quantity "R", the initial recoverable gas to the terminal pressure, it is derived from the sum of the quantities, Qa, which is estimated cumulative production to September 1st, 1950 and adding to that the quantity Qa, divided by the deviation of the gas Pa and Za in September 1st, 1950, minus the pressure at the terminal conditions **t** and the deviation at the terminal conditions **t**, divided by the initial reservoir pressure, divide that pressure by the initial deviation conditions

A (Cont.) minus Pa and the pressure by the deviation at condition A, which is September 1st, 1950. In effect, this is a pressure decline from initial conditions to September 1st, 1950, and conditions utilizing cumulative production and the deviated pressure drop from initial conditions to September 1st, 1950. The pressure at the September, 1950 condition being derived from using determined weighted average pressure of the Isobaric map on page 12. We found that, assuming the general factors in the Bow Island Sands and the Pendant d'Oreille field, with the same acre feet, and the acre feet derived from the measurements on our map on page 12, a gross estimated thickness of fifteen feet. The figure shown in line 18, under the equal pound loss method, is 740 billion cubic feet. By the volumetric system, under line 18, that would be 745 billion cubic feet as being initially recoverable to terminal pressure, in other words, having the average thickness of fifteen feet and of approximately 24% porosity and 25 connate water, would perform or have an initial reserve nearly to that indicated by the pressure decline method. Actually what we did that for was to check the validity of some of the volumetric calculations. Apparently we are dealing with about the right quantity of acre feet. Of void space for assumed porosity in pressure and connate water conditions, the combination of the factors in total, we could have some variation there, but we are within some realm of magnitude of both pressure decline and the volumetric calculation. Those figures were for the

A (Cont.) proved area. You will note that we have shown a sizable area of probable reserves in which we assume that the recoverable per acre would be about 50% of that shown for proved area due to the diminished thickness, the thickness being unknown due to lack of drilling; the scattered wells and a very wide saturation for that area. Since this map and these calculations were completed, the Britallo Company have completed three Medicine Hat gas wells well outside the limits we have shown, actually our limits were limited by the size of the map in this case.

Q MR. GOODALL: Did you take into account the migration of gas from the probable to the proven area?

A You will note that our original closed in well had a pressure line of 575 and has carried out a very considerable distance past the producing developed wells. We take the gradient shown within the produced area and attempt to carry it out until we reach, in effect, the original reservoir pressure, so that we would by this indicate no appreciable migration of gas from the probable area into the proven. We carried the proved area to original pressure in this case. The pressure data to support these is limited pretty well to these producing wells. Our feeling now is that whatever gas we have delivered up here is far too small for the Medicine Hat area, in view of the stepped up completions made within the last three or four weeks. The two wells I cited before are better than average Medicine Hat

A (Cont.) gas wells and would extend our proven probable area well to the east of the present limits an unknown distance and perhaps connect with the Many Island which is about twelve or thirteen miles east of the limits we have shown for the Medicine Hat field. By the same token, the Suffolk area produced from the Medicine Hat sand, and sofar as we can determine the saturation is continuous between Suffield and Medicine Hat and Many Island. It would be a matter of drilling wells in order to develop the gas. There may be many small sub-commercial wells developed, but a large number of commercial gas wells can be developed, in our opinion, that the area has a very large prospective reserve over and beyond anything that we have computed, and this will have to be revised and brought up to date and there will be additional wells.

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I believe that covers the examples of that type of calculation.

DR. GOVIER QUESTIONS THE WITNESS: Mr. Dougherty, I wonder if we could look again at the second tabulation you drew our attention to -- page twenty of Census Division 2., was it?

A The Pendant d'Oreille performance?

Q Yes, Pendant d'Oreille performance.

A That was the first one we attempted to calculate.

Q What page is that?

A That is the reverse side of page eighteen, Census Division 1. I would like to have our working papers if we are going to have any detailed --.

Q No, I won't have any detailed questions. I just want to ask you if in column five where you refer to daily average net gas delivery if that is the figure which we should determine as being the ability to meet peak gas loads.

A No, sir; that is just the annual daily average: that is,in effect, one three hundred and sixty-fifth of the annual take. We haven't taken into account peak loads, not knowing what they might be.

Q You show no figures in this report to show what we should take -- or rather, I should say, you show no figures that we should take as peak load figures?

A That's right. Our concept for that would be that average day, week, or month's requirements of peak loads could be met -- as we have done in many fields in the United States by balancing out the production in the year not to exceed whatever the authority may be -- if it is twenty-five percent, then twenty-

A (Cont'd) five percent over the whole year, with the summer load factor being able to decrease the peak load factor by producing thirty-five or forty percent for a given time, depending on the reservoir conditions and the ability of the reservoir to produce. It is our common practice. We make that general assumption for peak demands.

However, not knowing what the peak demands will be we have left that flexibility, additional wells or greater percentage taken for short periods of time. We don't anticipate that all of the fields will participate in a peak demand but that certain fields will come along at a certain production rate, very standard, and those fields which we could develop for additional capacity or high pressure delivery capacity would carry the bulk of the peak loads. However, we do that without being burdened, without burdening ourselves with certainty at this stage of the gathering project or deciding which fields could be used in that way in a producing system. It would be rather theoretical at this stage.

Q I imagine we will want to explore that further after we have had an opportunity of studying your submission.

THE WITNESS RETIRES

MR. PORTER: The engineering material is on its way here and should be here in ten or fifteen minutes and copies will be available to all parties. If you will just be patient, it will be here shortly.

THE CHAIRMAN: You just intend to distribute those?

MR. PORTER: I think there isn't much use starting a witness now.

THE CHAIRMAN: I think we can adjourn, then, until Wednesday morning.

(At this point the hearing stood adjourned (12:30 A.M.) until Wednesday morning the 9th day of May, A.D. 1951.)

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